Chapter 9
Bioeconomy in Maturation: A Pathway Towards a "Good" Bioeconomy or Distorting Silence on Crucial Matters?

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Abstract The bioeconomy as an emerging research field and policy framework has raised high expectations for enabling a shift to more sustainable practices. However, many of the solutions promoted under it have been heavily criticized for a lack of concern regarding the systemic effects in both environmental and social sustainability. In this article we analyse the differences between "1st round" bioeconomy policies and the revisions that have arisen from the critique ("2nd round bioeconomy policies"). We compare the two consecutive bioeconomy policy frameworks to views presented by a panel of Delphi experts. The experts elaborate on their views about a "good" and "bad" bioeconomy futures, with a long-range timeframe until 2075. The results indicate that the first round of bioeconomy policies contains many of the elements that the experts see as leading to an undesirable future. In contrast, the experts envisioned a "good" bioeconomy which would be based on a just and inclusive transition, a changed economic paradigm moving away from the focus on material growth, and a multitude of sustainable technologies, lifestyle changes, and balanced relations between business and politics. In the second round of bioeconomy policies, many of the issues addressed by the critique have been taken up, but problematic areas remain in the policies somewhat untouched. These include, amongst others, the question of biomass use for energy. We conclude that the bioeconomy finds itself now at an intersection between the old recommendations and novel, more inclusive goals. Are the expert panel's views indicative of the directions where national-level policy implementation is taking the bioeconomy? If not, how will the bioeconomy policies resolve the most burning critiques in relation to the overreaching policy goals to combat climate change? We argue that what happens

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in the next phases of bioeconomy policy implementation process will be critical for the fate of the entire bioeconomy project.

Keywords Bioeconomy · Circular economy · EU policy · Biomass · Delphi analysis · Future imaginaries · Technological expectations

1 Introduction

The bioeconomy rose on the policy agenda thanks to offering a set of promises that are tempting from various societal viewpoints. At the core of bioeconomy is a proposition that renewable resources could become the novel basis of the economy. This, on one hand, suggests that the bioeconomy has the potential to generate economic growth in a way that solves humanity's most pressing problem, climate change, which is strongly linked to fossil fuels. On the other hand, the bioeconomy in Europe has been seen as an opportunity to strengthen existing traditional industries, such as agriculture and forestry. Thus, the bioeconomy has brought a new kind of hope to the future prospects of the sectors and the people they employ. These expectations for the bioeconomy – fighting against climate change by substituting the fossils by renewables, creating economic prosperity as green growth, and securing the future of socially important sectors – are in line with the traditional representation of sustainable development through its three dimensions. However, there has been strong criticism towards the raised expectation horizons from the perspective of how attainable they truly are through the measures proposed by the initial bioeconomy program. Especially the gap between the goal of mitigating climate change and reaching it with the solutions offered by the bioeconomy, when considering the real environmental impact of the proposed measures, has been pointed out in the critique.

The critique could be expected considering the status of bioeconomy as an emerging research field and policy framework. As scholars in science and technology studies (STS) have argued, the hopes related to new technologies typically follow a certain pattern of dynamics of expectations.[1] The first steps of an innovation come with a vision, a story situated in the future, where the particular technology has solved problems or made life better. The first vision almost necessarily is filled with intentional exaggeration to get the needed attention, interest, and investment. This hype is built in intertwined networks of investors, regulators, policymakers, innovators, and consumers that form 'communities of promise'. When time passes, circumstances change. Problems evolve, and varying levels of

[1] See, e.g. Brown (2003), Brown and Michael (2003), Borup et al. (2006), Goven and Pavone (2015), Petersen and Krisjansen (2015), Van Lente (1993)

disillusionment drown the early hopes Members of the communities of promise reorient themselves to new visions, untarnished by disappointments.[2]

Politically created expectations can be described as normative images of the future that aim at bringing about futures that are framed as desirable. They are at their most effective at the stage when they address an emerging issue. This is, however, also the stage when uncertainty is highest and the actual effects of the created policies most uncertain. The hypes and hopes themselves are not morally neutral, but strongly normative. They are performative in the sense that even though the visions take place in the future, they influence our present. Visionary hypes grab attention and this has multiple effects. The field of technological innovation is highly competitive, and there is a race for investment. The best and most influential visions will most likely get support, acceptance, and resources. In this way, the most appealing hype suppresses other options. The agendas that are most novel are able to build up the most ambitious visions. This is because mature research fields have already gone through the cycle of disappointment and disillusionment. They appear mundane, familiar, and more boring; and therefore, they are doomed to lose in competitive funding and attention. It is easier to get excited with something completely new that promises radical easy-sounding answers. The biggest hypes tend to live only in the newest visions.[3]

In this article, we discuss the transitional period between two "rounds" of bioeconomy policies. The first round of such policies was initiated in 2006, and as discussed, it was characterized by an optimism regarding the potential of renewable resources to act as a basis of a new bioeconomy that could directly substitute the prevailing fossil economy. The policies and the expectations created on the first round received heavy criticism due to questionable assumptions regarding environmental and social sustainability. The updated EU-level bioeconomy policies (from around 2017 onwards) have responded to some of the key points brought up in the critique. However, the way EU-level bioeconomy policy documents are interpreted and implemented on the national level is an ongoing process, and thus the futures of bioeconomy policies remain a somewhat open question. Until the national policies are updated, the first-round policy recommendations are in effect and continue to affect the infrastructure and investment decisions that by themselves create continuity and development trajectories for the future. Also the global directions of bioeconomy present a major source of uncertainty for the assessment of bioeconomy futures.

In order to make sense of broader directions for bioeconomy futures and policies, we have analysed answers to a Delphi study exploring long-range futures of bioeconomy. In this study, we are especially interested in the Delphi panelists' evaluations of desirable and avoidable bioeconomy futures and their interlinkages to the first and second round of bioeconomy policies. The updated bioeconomy policies

[2] Brown (2003), 5–6; Deuten and Rip (2000)

[3] Brown (2003), see also Brown and Michael (2003), Borup et al. (2006), Deuten and Rip (2000), Goven and Pavone (2015), Petersen and Krisjansen (2015), Van Lente (1993)

are analysed against the long-range visions of the experts: what would the experts suggest for further measures and goals in order to reach the desired future bioeconomy? Experts' views regarding "good"[4] bioeconomy futures allow for an evaluation of the policies from the perspective of shared visions about what the goals of the policies should be. What they bring up reveal potential blind spots of policy documents: what kinds of topics are easy to include as responses to critique, and are the issues that are left unsaid or ambiguous in the policy guidelines?

In the conclusions we discuss our findings from the perspective of a theory of futures images.[5] They are a way to understand how individuals approach the futures through culturally shared bundles of concepts, values, and aspirations. Polak (1973) stresses the civilizational nature of the images. In this view, conceptions of futures stem from broader notions arising from a civilization's deep history and myths. Thus, one way to interpret the theory of images of the future is to see them acting as collectively shared filters for the kinds of narratives that are viewed as possible or plausible within a certain culture. In our conclusions we trace back our findings to a unifying narrative of the future that makes certain assertions more plausible and leaves others out from official representations.

With this study, we aim to contribute to several domains. First, we aim to provide actual guidance to policymakers and analysts as to what could be the potentially important future directions and blind spots in bioeconomy and climate policies that are in need of attention. Secondly, we wish to contribute to bioeconomy studies by taking part in the first wave of analyses of the updated bioeconomy policies. Because the updated bioeconomy policies are somewhat new, and academic publishing can be relatively slow, the updated bioeconomy policies are yet to be included in policy analyses on a large scale. Finally, our study, as a combination of policy analysis, science and technology studies, and future studies, is offering an example of a policy framework and research field in a process of transition and maturation.

2 Methods and Data Gathering

We took key documents from EU bioeconomy "first-round" policies to include OECD's *The Bioeconomy to 2030: Designing a Policy Agenda* (OECD 2006), followed by *The Bioeconomy to 2030. Agenda* (OECD 2009) and *Bioeconomy Strategy* in 2012 (EC 2012). The selected key documents for analysing the updated "second-round" policy were *Review of the 2012 European Bioeconomy Strategy* (EC 2017), *Updated Bioeconomy Strategy* (EC 2018), and *Realising the Circular Bioeconomy* (OECD 2018). Furthermore, the role of the bioeconomy in climate measures was

[4] Quotations are used in this article for "good" and "bad" to signal reservations about using such simplistic terms for complex and multifaceted, value-laden issues.

[5] Polak (1973), Bell (1996)

reflected by looking at EU-level general climate policies *A Clean Planet for all* (EC 2018) and *The European Green Deal* (EC 2019).

The first policies have been under a thorough critical analysis as it has been over the decade since their publishing. Due to the large number of existing analyses, one can find saturation in the analysis of different aspects of the data, and thus it was decided to partly rely on the existing analyses in reviewing them. However, as mentioned, policy documents since 2017 have received much less attention. For this study, these documents were qualitatively analysed by reflecting them from two angles: on the one hand, by viewing the updated documents in light of the main critical themes of the analyses of the first round and, on the other hand, by elaborating them against the Delphi experts' insight of "good" and "bad" bioeconomy.

The aim of the Delphi questionnaire was to provoke experts' thinking about long-term futures regarding bioeconomy developments. The Delphi method was originally developed for forecasting purposes in situations where trend forecasts and mathematical modelling were inefficient in providing useful information about the future.[6] Over the years, variations of the Delphi method have abandoned the forecasting aim, replacing it with a goal to foster fact-based argumentation about possible futures.[7] Consequently, the method has become one of the most popular methods in foresight and futures studies, and it has been adopted across different disciplines for assessing future developments by expert panels.[8]

The Delphi questionnaire was open to answering between March 27 and April 8, 2019. Key informants were selected to the panel by using an expertise matrix. The matrix was used to make sure that different viewpoints were represented in the invited panel. The questionnaire was completed by 64 experts representing 12 countries. Out of the 64 respondents, 52 came from countries within the European Union. Despite the use of the expert matrix for inviting the experts to join the study, the final makeup of the Delphi panelists answering the questionnaire was skewed towards more representation from researchers (17 of the respondents were employed by university or college and 11 by independent research institutes) and less from businesses (3 were employed by large companies and 3 by a start-up or SME). Also employers of governments or governmental agencies were strongly represented in the sample (10 respondents). Fields of science represented included social sciences, forestry, agriculture, philosophy, environmental sciences, innovation studies, economics, comparative literature, political history, and geography.

For the purpose of this study, we analysed the selected Delphi answers thematically and coded and grouped the themes that emerged from the data. The driving research question in the coding was to identify elements that the experts argued to be characteristics of a good and a bad bioeconomy and what they perceived as ways to reach them.

The data and methods of the analysis are presented in Table 9.1.

[6] Kuusi (1999)

[7] E.g. Tapio (2002)

[8] Linstone and Turoff (1975)

Table 9.1 Summary of the data and methods

Type of data	Method	Discussion
1st round bioeconomy policies[a] and related policy analysis[b]	Identification of key criticisms to 1st round bioeconomy policy	Are we approaching a "good" bioeconomy with the new policies?
Updated bioeconomy policies[c]	Qualitative analysis in light of the main critical themes of the analyses of the first round	
Selection from a Delphi questionnaire made to bioeconomy experts	Thematic grouping of elements of the experts' views on "good" and "bad" bioeconomy and key societal drivers to reach them	

[a]OECD (2006), OECD (2009), EC (2012)
[b]Main references include Bugge et al. (2016), Kleinschmit et al. (2017), Kröger and Raitio (2017), McCormick and Kautto (2013), Mittra and Zoukas (2020), Pfau et al. (2014), Ramcilovik-Suominen and Pülzl (2018), Staffas et al. (2013), Varho et al. (2018)
[c]EC (2017), EC (2018), OECD (2018)

3 The Rise of Bioeconomy Policies

The use of the term bioeconomy, or bio-based economy, started to increase in 2006, replacing its predecessor biotechnology as the buzzword in policy papers.[9] A key document that made the term popular was OECD's *The Bioeconomy to 2030: Designing a Policy Agenda* (OECD 2006), followed by *The Bioeconomy to 2030. Agenda* (OECD 2009). The European Union launched its *Bioeconomy Strategy* in 2012 (EC 2012).

The bioeconomy as a policy framework can to a large extent be explained through a double fold aim to both solve grand global challenges and at the same time produce economic growth in the spirit of knowledge-based economy and biotechnological revolution. Thus, it re-packages already existing programs promising growth and well-being through biotechnological and knowledge-based solutions, with aims to produce a sustainable transition in the world's economic and production systems. Such a combination is served as a manifold win-win strategy as reducing dependence on oil, tackling environmental challenges and climate change, making production and manufacture sustainable, creating jobs and new industry, and ensuring food and energy security. With a growing economy and diminishing environmental problems, it promises also to increase human well-being.[10] The cornerstones of this novel economy are biomass (e.g. from forest, field, sea, waste), innovation, and

[9] E.g. EC (European Commission), 2002. Life Sciences and Biotechnology: a Strategy for Europe; COM, vol. 27. Brussels, Belgium, 2002

[10] *A bioeconomy can be thought of as a world where biotechnology contributes to a significant share of economic output (*OECD 2009*: 8).*

*The bioeconomy's cross-cutting nature offers a unique opportunity to comprehensively address inter-connected societal challenges such as food security, natural resource scarcity, fossil resource dependence, and climate change while achieving sustainable economic growth (EC*2012*, 9).*

industrial biotechnology. Expressed in a most condensed form, in a bioeconomy, various biomasses are used to substitute fossil resources and to create added value to the economy.

3.1 Critique of the First EU Bioeconomy Policies

The inbuilt contradictions in a project merging goals of economic, environmental, and social interest have made the bioeconomy a target of a vivid academic discussion and review. Key questions include whether there is enough biomass for substituting for most fossil resources, along with all the other suggested uses for bio-based materials. What are the sources of this biomass? Who would the promised bioeconomy benefit, all or only the few? Who are included in decisions regarding these questions? Is the bioeconomy the only possible answer to the specific challenges it is claiming to solve? Two main streams of critique can be distinguished: the insufficient and immature discourse on sustainability and the costs arising from the one-sided, technology-oriented hype around bioeconomy. The summary of the critiques is presented in Table 9.2.

Table 9.2 Summary of first-round bioeconomy policy and its critique

1st round bioeconomy policy and its critique	
Dominating economic dimensions	Production, economic growth, and employment Aim to replace all currently used non-renewable resources with biomass
Lack of environmental and social dimensions	Undue optimism of available biomass (import, production increase, unused potentials and residues) No definitions or tools for measuring and assessing sustainability No critical views about consumption and material growth No concern for negative consequences of increasing biomass production, harvest, or import No concern for equity, social justice, local development, human rights
Harmful hype	Unjustified and speculative expectations Attention, resources, and policies directed to unrealistic and narrow technological fixes at the cost of socio-political research and interventions

*The bioeconomy encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products, and bioenergy. It includes agriculture, forestry, fisheries, food, and pulp and paper production, as well as parts of chemical, biotechnological, and energy industries (EC*2012*, 16).*

3.1.1 Sustainability: Taken for Granted and Neglected

Despite the emphasis on sustainability as a key argument for the bioeconomy in the first place, the bioeconomy policies lack due consideration of whether the goals of bioeconomy can be reached in a sustainable manner. In fact, the policy documents offer very little when it comes to discussion or definitions of sustainability in the context of the bioeconomy.

The first-generation bioeconomy discourse in the policy documents is founded on a myth and expectation of boundless amounts of biomass awaiting for its harvest. Scientific and policy literature lists sources of unused biomass potentials and residues and identifies existing and hypothetical measures to increase the amount of biomasses with better harvesting activities.[11] Sustainability of the bioeconomy is taken as a given – forests and land can be used to replace fossil resources because natural resources are renewable by their nature. We need data and policies to guarantee sustainability, but it can and will be done.

However, critical examinations of the policies have pointed out that no tools for measuring and assessing the sustainability of bioeconomy are offered.[12] Moreover, economic dimensions vastly dominate environmental and social dimensions in the sustainability discourse of the bioeconomy.[13] As a consequence, little attention has been paid to scarcity issues or management of natural resources or questions of justice[14]:

> The focus in the bioeconomy discussion is on production, economic growth and employment. Critical views about consumption and material growth are largely absent. All currently used fossil and other non-renewable resources cannot be replaced with biomass.[15]

There are various negative consequences to increasing biomass production, such as deforestation, losses of biodiversity, low water quality, land competition in food production, and large-scale land grabbing in areas such as Africa and Asia.[16] Local populations and small-scale farmers seldom have legal rights to their land, which intensifies problems related to the competition driven by large multinational companies in rural developing areas.[17] These problematic consequences have been linked especially to biofuel production[18] and cast a shadow on strategies relying on imported biomass.[19]

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[11] E.g. EC (2012), Winkel (2017)

[12] Staffas et al. (2013), McCormick and Kautto (2013)

[13] Ramcilovic-Suominen and Pülzl (2018); Mittra and Zoukas (2020); Staffas et al. (2013), McCormick and Kautto (2013); Varho et al. (2018)

[14] Ramcilovic-Suominen and Pülzl (2018); Mittra and Zoukas (2020); Staffas et al. (2013), McCormick and Kautto (2013); Varho et al. (2018); Bugge et al. (2016); Pfau et al. (2014)

[15] Varho et al. (2018), 29

[16] Ramcilovic-Suominen and Pülzl (2018), 4178

[17] Ramcilovic-Suominen et al. (2010, 2013)

[18] Arevalo et al. (2014), Danielsen et al. (2008), German et al. (2010), Obidzinski et al. (2012)

[19] Ramcilovic-Suominen and Pülzl (2018), 4178

Absence of discussion on the environmental and social sustainability of the bioeconomy, especially in its most prevalent bioenergy stream, is evident to a degree that it has led authors like Ramcilovic-Suominen and Pülzl (2018) to ask whether sustainable development in fact is only greenwashing, used as a selling point for the entire EU bioeconomy policy framework. There are however at least two sources of confusion that may explain the tendency to underplay the discussion on sustainability: first is the lack of a clear definition of "the bioeconomy" itself. When different countries speak about the bioeconomy, they speak about different things, depending on the local natural resource that each country aims to utilize in its bioeconomy.[20] This complicates also discussions on sustainability. Secondly, most of the knowledge production related to the bioeconomy originates from within natural and engineering sciences and industrial biotechnology that all have a focus on production, efficiency, and innovation, rather than wider, systemic consequences of the bioeconomy.[21] In some related policies, sustainability even primarily stands for safeguarding high production levels.[22] Even though sustainability is an integral part of (forest policies), technocratic orientations tend to narrow down the outlook on sustainable development.[23]

3.1.2 Harmful Hype

The other main target of criticism regarding the first round of bioeconomy policies has been their unjustified and speculative value propositions and ideologies.[24] At its core, the bioeconomy promises to solve climate change and other major societal challenges with innovative use of biomass. As discussed in the STS literature, the costs of such simplistic narratives stem from two main effects: (1) hype can have the effect of directing the discussion to unrealistic and narrow solutions, and (2) they may result in neglecting a search for other kinds of approaches that could be achieved via, e.g. socio-political research and interventions.[25]

The bioeconomy has been framed as the answer to "the most serious of "global challenges" –hunger, ill-health, and, especially, ecological crisis".[26] For instance, the OECD (2009) envisions overcoming environmental, social, and economic challenges mostly with biotechnological progress. In a similar fashion, a sustainable bioeconomy has been introduced as holding great promise to contribute to a

[20] Staffas et al. (2013), McCormick and Kautto (2013)

[21] Bugge et al. (2016), Mittra and Zoukas (2020)

[22] Kröger and Raitio (2017)

[23] Kleinschmit et al. (2017)

[24] Mittra and Zoukas (2020), 11

[25] Brown (2003), Goven and Pavone (2015); see also Brown and Michael (2003), Borup et al. (2006), Deuten and Rip (2000), Petersen and Krisjansen (2015), Van Lente (1993).

[26] Goven and Pavone (2015); 307

transformation of the entire economic system, with the move away from fossil-based production and consumption.[27]

Such hyperbolic framings are amongst visions that are seen as exemplifying "the aspirational political vision of technoscience as the ultimate solution to society's problems".[28] Together they contribute to a view where "human and environmental disasters are averted because a particular political-institutional configuration facilitated the development of profitable technological solutions".[29] The problem arising from a forceful propagation of a powerful, one-sided future vision is that a detailed diagnosis of the root causes of any current global crisis goes missing. And in the absence of such a diagnosis, it remains doubtful whether biomass-based economy can actually solve them. If the bioeconomy cannot redeem the promises it makes, there will be costs to the hype of expectations.

The kinds of powerful policy visions used to build a sustainable bioeconomy, irrespective of whether their promissory visions are realistic, have an impact on research strategy and organizational practices. Thus, they have a performative function: "The hopes and expectations that are embedded within the reports of national and international policy institutions, governments, and commercial organisations are not simply rhetoric. They have a material impact on what areas of science get funded and what kind of research is valued".[30] If attention, resources, and policies are directed to bioeconomy as a technological fix, attention is pulled away from much needed socio-political answers that should at least be a part of the solution. When it comes to the bioeconomy, visions that lead to neglecting socio-political causes to climate change can have an enormous effect. The idea that a technology-based economy could solve a problem that has socio-political roots leads the discussion astray. If the main emphasis is on hoping for a technological solution whose adoption would "automatically" result in a society-wide transition towards sustainability, the risk is that such a way out is revealed to be an illusion, and the needed socio-cultural measures would arrive too late, if at all.

The conclusion from the costs of hype is a paradox. Bioeconomy needs the imaginative speculation and hype in order to harness the needed resources and attention for its implementation. However, if hoping and hyping go too far and distort the discussion at the cost of other relevant aspects, it is harmful.[31] Thus, bioeconomy should be able to walk the thin line of hopeful and holistic realism.

[27] Winkel (2017), 14

[28] Mittra and Zoukas (2020), 12; Doezema and Hurlbut (2017)

[29] Goven and Pavone (2015), 305

[30] Mittra and Zoukas (2020), 12; Brown (2003)

[31] Brown (2003), 17

3.1.3 Suggestions for an Ameliorated Policy Approach to Bioeconomy

Ramcilovic-Suominen and Pülzl argue that in order to meet any of the sustainability approaches available in policy and scientific literature (that encompass at least three dimensions: economic, environmental, and social), the (EU) bioeconomy policy framework must be reoriented to entail environmental (biodiversity, air, water, and soil quality), as well as social, aspects (equity, social justice, local development, human rights).[32] Critical studies unanimously agree that the future evolution of the bioeconomy would have to build on a broader sustainability concept, as so far environmental policy integration and sustainability have only been integrated at the surface into bioeconomy strategies.[33] To facilitate this aim, Pfau et al. (2014) stress that the bioeconomy should be approached in a more interdisciplinary or transdisciplinary way.

After the first round of bioeconomy policies, and the extensive wave of critical policy analysis literature addressing them, policy directions have shifted considerably to comply with the suggestions. Furthermore, these very questions about the sustainable use of biomass were raised shortly after or during the first round of bioeconomy policy documents in background papers and workshops, inside policy. These then became (partly) visible in the second round of official strategies.

For example, a 2014 OECD workshop report discussed the essentiality of sustainable growth, harvesting, transportation, and trade of biomass to prevent societally detrimental practices and the risks of over-exploitation of natural resources that were inherent to policy recommendations of the time. Moreover, it discussed the lack of definitions for sustainability, measuring instruments for sustainable practices, and international agreements for indicators.[34] In background reports[35] used by the OECD (2014, 2016), the total supply of sustainable biomass in 2030 was assumed to realistically be enough to fulfil the demand in a 10% bio-based economy's final energy and feedstock consumption. A more ambitious ecologically sustainable bioeconomy in 2030 is foreseeable only by looking at optimistic assessments or relying on expectations of new technologies or potentials. However, "it should be realised that any number for its future potential is just a first guess".[36] As its main finding, a report concludes that "the conversion of a fossil fuel-based economy into a bio-based economy will probably be restricted in the European Union (EU) by the limited supply of ecologically sustainable biomass".[37]

As the OECD comments in 2014, the "success" of an ambitious bioeconomy might be in direct conflict with its original aim of tackling grand challenges. There is an urgent need for rapid action, "and yet we have not conquered the sustainability

[32] Ramcilovic-Suominen and Pülzl (2018), 4178

[33] Pülzl et al. (2017), 47

[34] OECD (2014), 10–11

[35] PBL (2012): EEA (2013)

[36] OECD (2014), 19

[37] PBL (2012), 2

issues around the changing needs and uses of biomass".[38] A problem in this conquest is that there is a general lack of agreement in criteria for the amount of sustainably available biomass.[39] The OECD recognizes that the priority in biomass use should be in food and feed and industrial uses should not be allowed to obstruct this. With these premises, the OECD wonders whether there actually exists any spare biomass or spare capacity of arable land.[40]

The external critique towards the first-round bioeconomy policies, along with an internal maturation process, has also been strengthened by the fact that concern about climate change has finally started to materialize into policy actions. This overall sea change in the policy context has created pressure for change in the bioeconomy context, too. In the following chapters, we shall examine how the main elements of the bioeconomy policy have developed on the second round of bioeconomy policy papers.

4 The Second Round of Bioeconomy: Cautious but Contradictory Narratives on Biomass

In the Review of the 2012 European Bioeconomy Strategy (2017), the European Commission states that:

> [T]he policy context in which the bioeconomy operates has changed significantly since 2012, with EU and global policy developments such as Circular Economy, Energy Union, the Paris Agreement and the Sustainable Development Goals. In consequence, the concept of a "circular bioeconomy" is being proposed by various stakeholders.[41]

The commission refers directly to the various criticisms that demonstrate the unsustainable aspects of existing bioeconomy policy. For example, the European Bioeconomy Stakeholders Manifesto (2017) concludes that:

> The bioeconomy can … not be based on the idea of substitution alone, but should be developed recognising that land and biomass, even when renewable, are limited resources. The bioeconomy should therefore be further developed in the context of principles of the circular economy, such as efficient use of primary natural resources, biodegradability and smart consumption, fostering innovation as well as changes in life style and diets.[42]

Followed by these critiques, the bioeconomy went on at least a major conceptual change. To offer a preliminary illustration, the titles and main action plans are compared in Table 9.3.

In the next chapters, we review key points that were updated from the first round of bioeconomy policies. On the one hand, the policies give reason to believe that the

[38] OECD (2014), 39

[39] OECD (2014), 12; OECD (2018), 41–42; Van Dam and Junginger (2011)

[40] OECD (2014), 5

[41] EC (2017), 41

[42] European Bioeconomy Stakeholders Manifesto (2017), 4

Table 9.3 Comparison of bioeconomy policy titles and action plans

Bioeconomy policy titles and action plans		
	1st round	2nd round
Title	Innovating for Sustainable Growth – A Bioeconomy for Europe	A sustainable Bioeconomy for Europe: strengthening the connection between economy, society, and the environment – Updated Bioeconomy Strategy
Action Plan headers	1. Investments in research, innovation, and skills 2. Reinforced policy interaction and stakeholder engagement 3. Enhancement of markets and competitiveness in bioeconomy	1. Strengthen and scale up the bio-based sectors, unlock investments and markets 2. Deploy local bioeconomies rapidly across Europe 3. Understand the ecological boundaries of the bioeconomy

discourse has entered into a new phase, founded on realism and sustainability. On the other hand, some of the highly criticized themes of economic emphasis and bioenergy are still ingrained in it. This results in major contradictions and leads to questions about the direction where the updated policies actually wish to guide the bioeconomy.

4.1 From Bioeconomy to Sustainable Circular Bioeconomy: Finite and Local Biomass and Land

In the updated Bioeconomy Strategy (EC 2018), the main concept used is *circular bioeconomy* or *sustainable circular bioeconomy*:

> To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernisation of our primary production systems, the protection of the environment and will enhance biodiversity.[43]

What does it mean to aim for a sustainable and circular bioeconomy designed to have biomass as its primary feedstock? In the updated bioeconomy policies, the abstractly expected "success of the bioeconomy" is put to more concrete questions of biomass.

As the OECD explains in a central policy paper *Realising the Circular Bioeconomy* (2018), circularity means the aim of keeping biomass in circulation. This leans on the idea of *cascade use* of biomass. Biomass should be primarily used in material bioproducts that keep biomass in the economy for longer, increase resource productivity, and create added value and jobs. The updated Strategy lists a number of examples of bio-based products and sectors that would be environmentally beneficial and value adding, such as construction materials, textiles, and

[43] EC (2018), 4

plastics.[44] Furthermore, circularity is intended to utilize "waste", "co-product", "by-product", "residue" sources of biomass such as agricultural or forestry residues, and municipal solid waste.[45] The OECD (2018) anticipates that a sustainable and circular bioeconomy would mean an innovative network of resource-efficient biorefineries with which a large amount of biomasses can gradually replace fossil-based production. The discussion on wastes, residues, and circularity supports a narrative of an innovative and resource-efficient bioeconomy.

This change in discourse from virgin biomass to varying degrees of circularity and cascading in bioeconomy processes brings to front a much stressed critique towards the first round of bioeconomy policies, arguing that in order to be sustainable, the bioeconomy practices cannot presume an endless amount of virgin biomass. Indeed, a central theme in the round two policy documents is the concern for the sufficiency and sustainable use of biomass.

The third key point in the action plan, understanding the ecological boundaries of the bioeconomy, aims at increasing overall knowledge and monitoring of the sustainable biomass supply limits at the local, regional, and global level.[46] Sustainability seems to mean here at least "the status and resilience of terrestrial (agricultural and forest) and marine ecosystems and their biodiversity …. their related socio-economic costs and benefits, and their capacities to serve as a sustainable domestic biomass source, to sequester carbon and to increase climate resilience".[47] Furthermore, the updated Strategy talks about "[t]he *finite* biological resources and ecosystems of our planet".[48] The limitedness of arable land is also recognized: land used to biofuel crop cultivation or bioproduction is away from human nutrition and might increase prices of food. Moreover, the amount of arable land used to feeding animals (40%) is presented critically,[49] thus hinting towards proposing changes in agriculture and eating habits.

Furthermore, the updated Strategy seems to discourage importing biomass: "Such a [sustainable and circular] bioeconomy will rely and capitalise mainly on domestically available sustainable renewable resources".[50] Although deploying local bioeconomies is not defined more specifically, the document can be read as a promotion of the use of domestic (or local) rather than imported biomasses. This might be a matter of employability and expenses (because biomass is expensive to transport[51]) rather than a matter of social sustainability.

If we look at the updated Strategy's aims in local cascade business models on bio-products, it is easy to imagine how the bioeconomy creates jobs, produces

[44] EC (2018), 41
[45] OECD (2018), 10
[46] EC (2018), 14
[47] EC (2018), 15
[48] EC (2018), 15 (emphasis added)
[49] EC (2018), 33
[50] EC (2018), 15
[51] EC (2018), 45

environment-friendly local products, and contributes to a more sustainable world. Examples on forestry-based textiles, furniture, and chemicals, innovative means towards more sustainable agriculture, and cities as major circular bioeconomy hubs create a narrative of a sustainable local bioeconomy.

Finally, the aim to preserve carbon sinks is an evolved theme. The Strategy 2012 primarily discusses wood as a resource for fossil-free energy and products: "Forests of the future will be increasingly dedicated to producing fibres, timber, energy or customised needs".[52] The increased demand for forest products is supposed to be met by speeding up forest growth and productivity. In contrast, the updated Strategy emphasizes the role of forests as negative emission carbon sinks and the need of reducing pressures on major ecosystems such as seas and forests. It recognizes the demand for increased harvest rates but acknowledges the related trade-offs and risks.[53] Thus, this clearly indicates that bioeconomy in this novel interpretation can also stand for the simple aim to grow and preserve carbon sinks.

4.2 Remaining Themes: Economic Emphasis and Bioenergy

It is worth to note that despite the many responses to voiced criticisms towards the first round of bioeconomy policies, it is not the case that the bioeconomy would have changed its direction altogether. The core policy objective remains in "the economy". With the Strategy's language, this means strengthening European competitiveness and creating new value chains and jobs by renewing industries and modernizing primary production systems. Despite the mentioned aim to "rethink growth models and extract more value out of our limited resources",[54] it is not entirely clear which priorities would prevail, if in conflict, economic, environmental, or social ones.

A large open question regarding what has truly changed in the round two policies concerns biomass. Despite the convincing tones of sustainable, circular, and cascade use of biomass, other narratives are available. There still remains an explicit expectation of being able to mobilize such a large amount of biomasses that the fossil-based production can be gradually replaced with bio-based raw materials.[55]

A related, large, and seemingly undecided area is bioenergy. The updated Strategy still emphasizes the role of bioenergy in the reduction of greenhouse gas emissions and meeting EU renewable energy targets. It is "expected to remain a key component of the energy mix in 2030".[56] In a way, this is a pragmatic expectation. The EU has successfully pushed binding national targets on renewable energy, and

[52] EC (2012), 31
[53] EC (2018), 9, 26
[54] EC (2018), 41
[55] OECD (2018), 7
[56] EC (2018), 5

bioenergy is the largest renewable energy source in the EU. Countries have rapidly began to utilize biomass in electricity generation and fuels.[57]

The talk of bioenergy does come with cautionary notes. As the updated Strategy acknowledges, "bioenergy production and use can also be associated to unintended environmental impacts, which need to be effectively mitigated by regulation and good practices at global and corporate level".[58] Problems related to using biomass to produce bioenergy have been noted in revised renewable energy policies,[59] and there has been some reinforcement in the EU bioenergy sustainability criteria.[60]

However, apart from these sustainability criteria, there are no systematic restrictions on the direct use of biomass for energy purposes.[61] In the existing bioeconomies, biomass for energy use is dominant. By mid-2015, at least 154 countries had targets on renewable energy, mainly based on wood and crops. There are few policies that give such attention to bio-based materials and chemicals.[62] For example, a large proportion of the global trade of wood pellets is done for meeting climate obligations by burning them for bioenergy to generate electricity or heat.[63]

Moreover, most of the world's existing biorefineries are first-generation ethanol mills that use food crops as feedstocks.[64] The OECD notes this but emphasizes that "biorefining in the current context should be concentrated on second-generation biorefining, where feedstocks consist of non-food resources (renewable or non-renewable). Very often these will be waste materials. Along with agricultural and forestry residues, in theory this is a large stock of potential feedstocks".[65] The strategic focus is clearly on developed and circular, that is, waste-based biorefineries. However, will it be possible to transform or substitute existing mills to meet this aim? Do the new policies give due guidance and direction to this?

The emphasis on bioenergy – even if it was decreased from the Strategy 2012 – enables still building a bioeconomy narrative where crops and forests are turned into burnable resource for making biofuels. In a sense, this is very logical because the burning of fossil resources is the source of the majority of emissions the world is desperately trying to get rid of.[66] However, it is not the case that the problem of fossil fuels could be fixed with bioenergy. Even though any application of fossil resources could technically be replaced with biomass, it is not reasonable to expect this. Bioenergy is inefficient compared to fossil energy, and there are major

[57] EC (2017); OECD (2018)

[58] EC (2018), 49

[59] EC (2016); Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources

[60] EC (2018), 49

[61] OECD (2018), 9

[62] OECD (2018), 50

[63] OECD (2018), 44

[64] OECD (2018), 12

[65] OECD (2018), 12–13

[66] OECD (2018), 57

Table 9.4 Key conflicts in bioeconomy policies from 2017

Key conflicts in bioeconomy policies from 2017	
Stated aims of biomass use	*Sustainable*: sustainability limits at local, regional, and global level; socioeconomic costs and benefits of biomasses must be balanced; recognition of the limitedness of arable land available biomass *Circular*: "wastes" and residues instead of virgin biomass *Cascade*: material bioproducts that keep biomass in the economy for longer, increase resource productivity, and create added value and jobs *Carbon sinks*: reducing pressures on major ecosystems, carbon capture *Local*: Local biomass comes with social and environmental problems
Contradictory contents	*Replacement*: expectation of mobilizing such a large amount of biomasses that the fossil-based production can be gradually replaced with bio-based *Growth*: core policy objective is in competitiveness and growth *Bioenergy reliance*: no systematic restrictions on the direct use of biomass for energy purpose, a key component of the energy mix in 2030, prevalent type of the current bioeconomy. However, untoward social and environmental effects of cultivation are noted

conversion losses in the production of it. Bioenergy could sustainably meet 10% of the EU's energy need.[67] Bioprocesses are "notoriously inefficient" compared to fossil-based production.[68] Utilizing waste and residue biomass would be a sustainable solution, but the potential supply estimates of these do not indicate they would become the dominant feedstock. Overall, background calculations recommend only a low priority to the application of biomass in power generation – instead, they would recommend focusing on other sources, such as solar, wind, nuclear, and hydropower, when it comes to power generation.[69] This skepticism does not undermine, however, the importance of bioenergy in selected areas. Biofuels will most likely be needed in heavy traffic or aviation. The point is that biomass should be used to produce biofuels only when no alternatives exist, in prioritized applications. This would constitute a "roadmap towards a low-carbon, partly bio-based economy".[70]

The evident conflicts between the stated aims of biomass use and the discussed contradictory elements present in the policy documents are summarized in Table 9.4.

4.3 The Conflicting Roles of Bioeconomy in Climate Measures

The likely future trajectories of the bioeconomy can be further reflected on by looking at recent EU climate change-related policy documents. *A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and*

[67] PBL (2012), 7–9, see also Partanen et al. (2014)

[68] OECD (2018), 41; Philp (2015)

[69] PBL (2012), 9, 14

[70] PBL (2012), 14

climate neutral economy (EC 2018b) and *The European Green Deal* (2019) paint the big picture of EU's vision for a transition towards sustainability. What is the role of the bioeconomy in these, and do they shed light to some of the open questions presented in the previous chapter?

The general policies emphasize circular economy and energy efficiency, deployment of carbon sinks, electrification with renewables (solar and on- and off-shore wind, ocean energy, nuclear), changing agroforestry techniques, and changes in mobility patterns (e.g. reducing travel and massive decreases to road transport of freight). They promise regulative measures towards sustainable practices by revising multiple pricing and taxing sectors according to environmental burdens, ending fossil fuel subsidies and tax exemptions, and encouraging reusable, durable, and repairable consumer choices. The tones of promoting planetary boundaries are intensive. However, the green deal is presented as a strategy of growth that relies on the idea that economic growth can be decoupled from resource use.

The need for a just and inclusive transition and taking care of distribution of harms across areas and groups of people is recognized to a great extent. The main reason for this is that successful climate actions must be done with speed and effectivity, and this is possible only with a wide public acceptance as citizens are active participants and consumers in the transition. Wide public acceptance can only be gained by making the transition fair and inclusive.[71]

In these climate policies, the bioeconomy is a partial solution but is presented as a contradiction: We need it, but EU forests alone cannot deliver necessary biomasses. Importing is problematic, sinks should be enhanced, and land for biomass production is scarce. Other, perhaps even more important, measures are other renewables that enable electrification, policy actions that force (by regulation or by price) decreasing the use of fossils, and changing behaviour, e.g. in traffic (less wheels and fuel) and land use (food or feed, agriculture). Thus, tackling climate change is by and large seen a political task – not only of accelerating the use of new technology or innovation but a wide and complex socioeconomic task, comprising a wide transform of subsidies, taxation, and pricing to meet environmental goals.

With this in the background, and looking at the different narratives on bioeconomy, the major objective of the bioeconomy becomes ambivalent. If it is "the gradual replacement of fossil-based production with bio-based",[72] and the "defossilisation of major industries, such as the energy and transport sectors, the chemical industry (e.g. plastics), and the construction sector",[73] what is the speculated role of the bioeconomy in these replacements? The answer to this question is a key determinant to how sustainable the bioeconomy can be.

One way to conceive of the promise of the bioeconomy is to see it as proposing to save the planet by replacing fossil fuels gallon by gallon and plastic bag after plastic bag. However, this narrative builds on the notion of infinite biomass, which

[71] EC (2018b), 21–22

[72] OECD (2018), 7

[73] EC (2018), 32

has been the main point raised in the critique. Thus, this particular vision of world-saving turns into its opposite. In contrast, if the aim is to replace some fossil resources by, for instance, promoting novel practices in agriculture and forestry, the image of a truly sustainable and circular bioeconomy created is certainly much more credible. However, in the latter narrative, the dramatic effect of offering a silver bullet to solve the grand challenges is mostly lost. It then seems that the bioeconomy can be either perceived as a "world-saving" unsustainability monster or understood as a partial, small-scale answer, to drive transition to sustainability by a change in local practices.

The updated bioeconomy policies remain ambivalent in taking sides in this regard. In the second-round bioeconomy policies, one can see that the biggest hype around the bioeconomy has faded, but the bioeconomy is still seen as holding an important, if not, key role in efforts to drive sustainability:

> Even though the production of biological renewable resources is also associated with greenhouse gas emissions, resource consumption and other environmental risks, there is growing understanding that deep defossilisation and remaining under the 2 °C limit will not be possible without sustainable bioeconomy activities, given their potential for carbon sequestration, the substitution of fossil resources with sustainable biomass-based resources, and their large greenhouse gas emission reduction potential related to more resource efficient and sustainable production patterns.[74]

Thus, the bioeconomy can produce emissions and environmental risk, but we need bioeconomy to tackle emissions and environmental risks. Bioenergy can be good, but it can be bad. Cascade use is good for the environment and for the society, but it does not provide a direct answer to the existing biggest emissions.

Despite these contradictory remarks, it is evident that the hype on simplistic technological fixes or scientism, criticized in the first round, has decreased. Even though the OECD holds that "science and technology quite clearly hold the answers to many of the questions regarding this low-carbon, non-fossil future, as evidenced by the growth of solar and wind technologies",[75] it also states that:

> Whenever humans intervene in a system, from the level of genetics to whole community, all the way to globally, there are interactions with other components of the system, and new consequences. The 'behaviour' of these grand challenges is assuming characteristics of an ecosystem: an intervention in one location results in changes there but also elsewhere. Ultimately the goal is interacting solutions to interacting grand challenges. This calls for multi-disciplinary research and systems innovation. There is no simplistic technological fix.[76]

What the OECD calls for to address these contradictions is efficient allocation of biomass to chemicals, materials, and energy; balancing societal benefits in different biomass uses; better knowledge on biomass volumes and measuring sustainability; and levelling the playing field for cascade use of biomass by removing fossil fuel

[74] EC (2018), 32

[75] OECD (2018), 50

[76] OECD (2018), 8

subsidies and pricing the environmental damage of those industries.[77] At the same time, it warns about potential regulatory deadlock that overly strict policies regarding biomass use might produce.[78] The OECD actually suggests a guide to prioritization in case-by-case analysis: climate change mitigation (including preserving important carbon sinks), protection of the environment (especially forests) and the people, energy security, economic stability, and job creation.[79]

The concrete consequences of the conceptual change will only be seen when the EU puts the new policies into action, and individual countries update their respective bioeconomy strategies, interpreting and implementing the new EU-level policy documents. The essence of the bioeconomy might be at the edge of a true paradigmatic shift, or it can remain the same with superficial additions in policy papers.

5 Delphi Analysis: Imaginaries of Good and Bad Bioeconomies Towards 2075

In this chapter we present narratives of futures images of "bad" and "good" bioeconomies in 2075. They are constructed from experts' answers to two questions from the Delphi questionnaire: (1) experts' conceptualizations of what would constitute a "good" and a "bad" bioeconomy in the year 2075 and (2) the panelists' insights regarding the main societal drivers and key factors in either failing or succeeding in reaching the IPCC's climate targets. The respondents unanimously held that a determining characteristic of a "good" bioeconomy is a strong contribution to halting climate change. Therefore, the answers that elaborate key societal drivers in reaching the IPCC's climate targets can be understood as pathways to a "good" bioeconomy, and vice versa in the case of descriptions of a bad bioeconomy. First we present concise summaries of the "good" and "bad" bioeconomies as elaborated by the expert panel. A table of thematically grouped quotations (Table 9.5) shows how these visions are grounded in the original Delphi responses. In order to represent the rich data and do justice to the multifaceted causality chains in the arguments, we have chosen to present the findings as constructed narratives on the pathways that have lead to undesirable or desirable outcomes for the bioeconomy in 2075. These are presented after the quotation table.

The experts' view of a "bad" bioeconomy has failed in changing the course of the climate change progression and is successful mainly as a greenwashing strategy. In many respects, the bad bioeconomy is a continuation of "business as usual" as it continues on the same economic paradigm and behavioural trends of the present, aiming to a simplistic replacement of fossil resources with renewables. It has not affected fossil use, and the bioeconomy-related practices are harmful for the

[77] OECD (2018), 31, 42, 54

[78] OECD (2018), 31

[79] OECD (2018), 31

Table 9.5 Dimensions of "bad" and "good" bioeconomies

	Dimensions of bad and good bioeconomies	
	"A bad bioeconomy….	"A good bioeconomy…
Political	…is too little and too late". …is the paralysis of the political class, a lack of public will and societal integration". …lacks the willingness to coordinate and cooperate on a global level". …is based on short-term self-interest and denialism, greediness of money and power". … is made from corruption of government by big business and strong lobby from the fossil fuel and agricultural industry". … consists of idiots in all bigger governments".	…has massive pressure from citizens and consumers". …has strong political action and commitment from world leaders". …relies on proper risk communication that manages mobilization and lifestyle". …is made by a new generation of leaders". …produces changes in legislation and culture".
Economic	…continues the exploitative linear economy". … is myopically focused on growth and allows it without limitations". …aims to replace all fossil based raw materials with bio-based ones". …is an unconstrained market economy". …is continuing to use petroleum as the foundation for our economy". … plays in the hands of the global companies". … is based on consumerism".	… entails a paradigm shift from continuous economic growth". … reduces the overall level of consumption". …is reasonably small. Biological resources cannot be used to the extent fossils are being used today". …is a true circular economy where everything is re-used, recycled and shared". …is a global agreement to revise the rules and frameworks that govern our markets". … uses biomaterials only based on "true" needs".
Social	…aggregates benefits to few". …is a policy agenda decided by a small elite". … ignores the rights of indigenous peoples". … benefits large corporations and makes the lives of people dependent on bioresources more vulnerable". …does not pay heed to issues concerning equality, poverty, workers' rights, etc.". … does not provide jobs and well-being to communities".	…is one where the global population is stabilised". …addresses wealth inequality". …distributes biological resources justly". … is an inclusive economy that takes into consideration needs of all stakeholders". …provides equal opportunities to participate in decision making". …is an economy where less people live in poverty".

(continued)

Table 9.5 (continued)

	Dimensions of bad and good bioeconomies	
	"A bad bioeconomy….	"A good bioeconomy…
Technological	…offers technological fixes to our environmental and social predicaments". …uses low-level technology, similar to current biodiesel or other first-generation biofuels". …uses biomass for energy".	… emphasizes socio-ecological circularity and innovation, rather than technological solutions". …is radical technologies for health and energy". …is represented by rather small to medium-size scale biorefineries available locally". …provides massive decarbonised electrification of whatever is possible".
Environmental	… is harmful for the ecosystem". …fails to make a contribution to climate change". …is a word for green-washing". …does not balance carbon sinks against the use of bio-based materials". …exploits the globe's natural resources beyond the limits of sustainability". …fails to balance economic systems with the planetary boundaries".	…is a tool to reach a fossil-fuel-free society". …does not aim to replace all fossil based raw materials with bio-based ones". …is locally sourced and sustainable". …is about safeguarding natural resources". …increases biodiversity and carbon sinks". …uses biomass for energy only in a very limited manner, if at all". …uses agroecological methods in agriculture".

environment: they are economically wasteful and utilize old-fashioned technologies, and biomass is routinely used for energy production. The bad bioeconomy is based on exploitative relationships between humanity and nature, but also between individuals and different nations. It is culturally insensitive, socially divisive, and unjust. As a result of a bad bioeconomy trajectory, the experts anticipate widespread societal and ecological problems that are difficult to mend. Table 9.5 presents thematically grouped quotations from the authentic Delphi responses. Quotations have been slightly formatted to fit into the table.

Aspects of a "good" bioeconomy, according to the expert answers to the questionnaire, include the protection and certifying of natural resources and distributing them in least harmful ways. The experts emphasize the importance of creating a sustainable economic model, where the economic paradigm has transcended the current focus on material growth and consumerism. Instead, sustainable consumer behaviour and distribution of the benefits generated by the bioeconomy in a just and equal way are at the core of a "good" bioeconomy as envisioned by the expert panel. Also, such economies in the views of the experts would be relatively small and local. Fossil use would be minimized and where feasible substituted by renewables. However, low-carbon goals and combatting climate change are key priorities, and

there circular bioeconomy overrides the earlier substitution-based thinking. Smart and sustainable technology, combined with regenerative approaches across the board, provide the tools for reaching a good bioeconomy. Economical issues are in balance with the goal of environmental protection and enhancement of biodiversity, as well as with the aim to provide conditions for flourishing and well-being.

5.1 A "Bad" Bioeconomy in 2075

In the bad bioeconomy scenario, the world has continued on the unsustainable path that much of the human societies already were on in 2019. The word bioeconomy has largely come to represent a particular greenwashing strategy, which for long had distracted citizens from the urgent need to shape lifestyles and societal structures towards more sustainable practices. The main reason for why societies were not able to move on to a sustainable path through the bioeconomy was that too little was done to change the harmful practices through policy, within the timeframe they would have still been effective. One major obstacle in the path towards a sustainable bioeconomy was getting stuck on the idea that biological resources could be used to the extent fossil resources were used earlier. Most of the difficulties experienced in implementing sustainable practices can in retrospect be linked with this fundamental inability to change mindsets related to consumption and material growth.

The failure to halt climate change is clearly evident in 2075, and any attempts to reform the systems to being less destructive are generally perceived as too little, too late. A major factor that has kept things rolling towards the wrong direction has been the inability to change economic priorities and the linear, exploitative economic model, connected with the prevailing consumerist lifestyle. A general lack of belief in change and collective action has coloured the decades since 2019, and this bleak social mood has contributed to the reluctance to regulate markets. In sum, the failures resulted from the passivity of ignorant and hopeless citizens, lack of a political vision, and nihilistic businesses. Despite climate change being a constant point of discussion on international political sphere for decades, it did not successfully challenge the prevailing economic dogma. An underlying reason for the slowness or lack of action was the persistence of old power relationships: old habits, the overriding goal of economic growth as the guarantee of human welfare, and related assumptions regarding competitivity combined with the dependency of the societies on fossils. Together they slowed down progress towards more ambitious policies. A general lack of confidence in the political decision-making has been a key factor that has prevented making political decisions quickly enough, and important decisions made by politicians in big countries such as the USA, Brazil, and China have greatly affected the development of climate action globally.

Earlier, there had been changes in values that speeded up the transition from material to immaterial consumption, and in some circles there was even readiness to adopt degrowth-based practices and policies. However, these remained as niches for a long time, while globally, the more or less official assumption remained that all

fossil fuels would be used anyway, and any efforts to substitute them would only slow down the process rather than end it. Within societies, societal disintegration had made the task of forming collective resolutions more challenging. The soft market-based measures implemented to support changes in consumption were successful only in addressing the consumption patterns of the relatively rich, well-educated people. Although their behaviour was at the heart of problems, the chosen policy approach was not enough to affect progress of climate change. Also, it perpetuated the impression that only elites were the concern of the decision-makers (who also belonged to the same societal strata), contributing to a general sense of social injustice permeating many societies. Western consumption-based lifestyles were held up as the ideal in developing countries. Benefits from the bioeconomy had mainly gone to societal elites, while minorities had seen their rights and social standing continuously diminishes over the course of the past decades. Globally, the practice of importing biomass from the developing countries had caused widespread social and ecological problems while providing only little as revenues for the countries to mend the damage done. Efforts to share the positive financial results justly with the developing countries thus failed and led to a continuation of high population growth and unsustainable development patterns. At the heart of the problematique was a general hopelessness, and a lack of adequate risk communication that would have acknowledged and respected the emotions and psychology of people. Challenges seemed unsurmountable, and for instance, the melting tundra and the burning of forests appeared to be unstoppable natural events that automatically would continue to generate CO_2. Lack of resources caused poverty and hunger amongst fast-growing populations.

Societal pressure ultimately, as climate change impacts were already clearly visible and disturbing daily lives, gained enough strength to turn the policies around to adopt more stern measures to combat climate change. However, this happened too late to be able to have a significant effect on hindering or mitigating harmful effects of warming.

Corruption of governance by big business interests was responsible for major delays in climate action. It was manifested in different ways: denying climate change, delaying climate action measures by serving interests of selected stakeholders (e.g. nationally important industries), and promoting fear of losing wealth and jobs. As no incentives or restraints were present to hinder the drive to make profits, the economic system, but also sub-systems like agriculture, continued to rely on the fossil industry and perpetuated the approach based on extractivism, global inequality, and a false idea of nature as abundant, self-correcting, and "larger than humanity". In the absence of clear policy guidelines or incentives, and with all the more pressing economic concerns, technological development and application of novel technologies started to lag, and many businesses continued with using rudimentary first-generation technologies in biomass exploitation biorefineries. Bio-based resources were routinely applied for linear bulk use, like fuel and energy production.

Even if decline in human health, competition for resources, and population migration had underlined the need to replace fossil energy sources, the politicians were rendered unable to act in a world characterized by combined effects of the

climate change-related calamities: wars, natural disasters, effects of reduced biodiversity, population growth, inequality, more mobility and flying, and the heating of climate. Societies lacked abilities to cooperate or coordinate their responses to ever-mounting challenges, and the political class had resigned their power mostly to the business interests that were dominated by short-sighted and selfish greed of money and power. The public lacked will and confidence to try to affect changes. The same dynamics also were at work on the global scale, leading to global inaction as regards mobilizing to tackle climate change. The problems culminated to an inability to make necessary political decisions fast enough, resulting in political leaders paying attention to insignificant small questions to attract the voters' attention, to focus on technological fixes, and a reluctance to think through measures to bring about systemic change. Rather, the bioeconomy proceeded as direct substitution of fossils by renewables that resulted in unsurmountable ecological problems.

5.2 A "Good" Bioeconomy in 2075

The success of halting climate warming can to a large extent be credited to changes made to the previous economic paradigm. This was triggered by a search for a good life and a good society, brought up by an awakening to the state of the environment in the first decades of the second millennium.

The dramatic changes were first initiated by decisive action from the citizen society, where individual opinion leaders and political movements acted as primus motors insisting on change. These movements were instigated by climate-related catastrophes and fear, but with proper risk communication, they paved the way for a global change in attitudes. The citizen pressure, combined with calls for action from sustainability-oriented businesses, was able to draw strong commitments from world leaders and political deciders. At the same time, businesses and industries had begun to respond to a turbulent, unsecure, and unpredictable political and economic environment by starting to favour local, small-scale operations.

A global agreement to revise the rules and frameworks that govern the markets was reached in order to prioritize environmental and social sustainability. Also other international agreements moved forwards, with all the significant countries joining in. Land management became more efficient with clear policies such as prioritizing food over feed or energy, and massive afforestation efforts were taken as a result of placing various incentives for environmental protection. Even conservative and large corporations abandoned fossils and adopted sustainability-driven missions and strategies.

Together, the combination of value changes, soft market measures, and policy enforcement diminished energy use, mobility, and eating meat and lowered the overall level of consumption. In general, consumption and material welfare seized to be perceived as status symbols. The UN Sustainable Development Goals were an important framework for deciding on the social, economic, and ecological changes. A shift towards a just, equal, and inclusive distribution of resources, goods, and

wealth globally has had direct consequences for the sustainability of societies, but also side effects that would have earlier seemed utopian, such as the elimination of poverty, equality between the sexes, and universally available education. These have, amongst other things, led to a more balanced demographic structure.

In the context of a rapidly developing bioeconomy, sustainability of the raw material production and ensuring the maintenance, or in many cases increase, of biodiversity were key considerations. Early on it was realized that replacing all fossil-based raw materials with bio-based ones was not sustainable or good for the biodiversity. Thus, separating out the industrial segments where this was worth doing and where it was not was an important process that later on proved beneficial for the sustainability of the bioeconomy. Another key focus area was to make sure that fossils were not simply substituted, but that major efforts were made in reducing primary consumption. Countries enacted policies that strictly regulated the use of virgin raw materials, and so circularity and recycling became the foundations of the bioeconomy. Regenerative farming techniques were used to bind carbon to the soil while producing a varied and healthy nutrition for the increasing population. All in all, the bioeconomy was in many ways crucial in helping humanity transcend to a world beyond fossil dependency.

The most important technological enablers of the transformation were the fall in the cost of renewable energy and battery technology, with a wide-scale electrification. Diverse wood-based solutions are mainly used as bio-products in 2075. Due to sustainability issues, the role of bioenergy in the portfolio of renewables has been dramatically decreased. Bioeconomy means not just technological fixes or one major technology but is seen as a multifaceted area providing many answers to the quest for sustainability.

6 Are We Approaching a "Good" Bioeconomy with the New Policies?

In this section, we estimate the updated bioeconomy policies in light of the experts' insights of characteristics of a "good" and "bad" bioeconomy and in light of whether the critique of the first-round policy is answered. How close are the recent policies' directions to what a "good" bioeconomy would be? Are there some elements of a "bad" bioeconomy that remain?

The thematic main characteristics of "bad" and "good" bioeconomy, the first-round policies, and updated bioeconomy policies (with some added notes from the bioeconomy-related general climate policies) are presented in Table 9.6. We reflect the policy changes against the experts' notions of a "good" and a "bad" bioeconomy trajectories by comparing overlapping themes that emerged from both data: the role of bioeconomy as a technoscientific answer; narratives on the use of biomass; visions of economic paradigm and values, the role of justice, and inclusion in the transition; and views on the required political and societal mindsets.

Table 9.6 Comparison of the Delphi experts' "bad" and "good" bioeconomy with first- and second-round bioeconomy policies

Dimensions of current and future bioeconomies			
"Bad" bioeconomy	"Good" bioeconomy	1st-round bioeconomy policy	2nd-round bioeconomy policy[a]
Political: Political and societal mindset			
Societal disintegration No public will Too little too late Short-sited politicians Selfishness, greediness of money and power Lobby and corruption prevent change	The world united Collective action Societal pressure Belief in change Committed leaders Interest groups and corporations join targets Psychologically effective risk communication		Effective policy implementation needs active citizens and public acceptance[a] Tackling climate change is a political task[a]
Economic: Economic paradigm and economic values			
Linear and exploitative emission-heavy economic growth guarantees welfare Only soft market measures restrict and direct to sustainability Consumerism prevails	Prioritization of environment and social sustainability Revision of rules that govern markets Strict regulation of all virgin raw materials Change in consumer behaviour and culture	Focus on economic output and growth Continuous or even increased production Economic priorities dominate environmental and social ones	Core focus in growth and competitiveness Soft and hard regulation Industry less dependent on new materials Reliance on decoupling No real restrictions to energy use of biomass
Social: Justice, inclusion, equality			
Benefits to few, social injustice Ignore the rights of minorities, decisions by a small elite Importing biomass from developing economies Fast growth of population	Equal distribution of benefits, just transition Inclusive decisions Just distribution of natural resources Education of girls and equality of sexes to halt population growth	Lack of discussion on social and cultural matters of bioeconomy No attention to unethical import of biomass	Balancing societal aspects in different biomass uses Just and inclusive transition[a] Taking care of people with low income[a] Concerns about biomass import[a]
Technological: Technoscientific fixes and their limits			
Focuses on technological answers Fossil use merely replaced with another resource Lack of necessary innovation Inability to implement existing technology	No just technological fixes Reducing primary consumption Innovations to circularity and sustainability Cheaper mass markets Large electrification	Technoscience is a main solution Reaching sustainability taken for granted Infinite biomass can replace fossil resources	Decreased hype on technological fixes Sustainability taken seriously Finite biomass and land Not only replacement but some reducing[a] Large electrification[a]
Environmental: How biomass is used			

(continued)

Table 9.6 (continued)

Dimensions of current and future bioeconomies			
"Bad" bioeconomy	"Good" bioeconomy	1st-round bioeconomy policy	2nd-round bioeconomy policy[a]
Biomass overuse Linear bulk energy use No changes in land use, unsustainable agriculture Global exploitation	Circular cascade use No bulk use for energy Massive land use changes: afforestation, sinks, carbon capture… Local biomass sourcing	Central role to biofuels and bioenergy Inadequate attention to resource scarcity	Circular cascade use Bioenergy reliance Land use changes: sinks, regenerative methods… Local biomass sourcing

[a]*Notes from the Clean Planet (EC*2018b*) and Green Deal (EC*2019*)*

As we have elaborated above, the experts' views of a "good" bioeconomy rely on a holistic and socio-politically oriented diagnosis of climate change that does not see technoscientific fixes as a probable solution. This understanding is visible in the updated policies where the limits of technoscientific solutions are recognized. Sustainability is taken seriously, and the finitude of biomass and land for its cultivation are acknowledged. However, it is uncertain to what extent the policies have moved from mere replacement of fossil resources to promoting massive decreases in primary consumption.

This is not to say that technoscientific solutions would be of less worth. The experts emphasize the need to implement a variety of sustainability-promoting technologies and worry about their speedy and effective implementation. However, the scale in which citizens and other agents in the society are able to adopt and start using new solutions poses a limit to technological solutions. The new strategies do emphasize innovation and the need of fast implementation with market measures, but a fast transition needs to be a just transition.

The planned uses of biomass in policies are similar to the visions of a "good" bioeconomy. Locality, circularity, and cascading of biomass are central in the new policies. Land use changes are on the list, but are they as massive as the experts call for? The challenging open question is the role of bioenergy and biofuels in narratives of future bioeconomy. Some of it is arguably needed, but large-scale production is undesirable. Currently, "the bioeconomy" predominantly means cultivating crops for biofuels. Thus, a major shift should take place. To what extent do the policy documents acknowledge this?

The experts see a change to the current paradigm of linear growth as a key factor in reaching the climate targets and a "good" bioeconomy. The new policies offer some hints towards this. There is a will to use heavier regulation to direct economic activities towards sustainability and reduce dependency on new materials. However, it seems most of these regulations are softer market means, while the experts would wish also for a strict regulation of all raw materials. Even though strict regulations can produce untoward effects, the lack of genuine restrictions to the energy use of (raw) biomass seems to be at odds with the vision of a circular and sustainable bioeconomy.

Furthermore, the policy documents' core focus remains in economic growth and the myth of decoupling economic growth from resource use.[80] This creates a major threat to the aim of reducing primary consumption. Without a systematic re-conceptualization of "economic growth", it is an open question whether primary consumption could really be decreased. The prevailing dogma of growth does not help to shift consumerist behaviour, either. The experts view this as being a key factor in need of change. The strategies have elements of guiding the decrease of some unsustainable habits such as travel, food, and energy use, but there is no discussion on the need to affect the mindset regarding consumption culture as the cornerstone of welfare and status in the society.

The image of a "good" bioeconomy based on the Delphi experts' arguments is just, inclusive, and equal. These issues are also progressively visible in the new policies. It remains an open question to what extent these intentions translate to changing practises in different nations. In the expert's views, taking care of a just transition is important, but it is mainly discussed in relation to the overall success of the sustainability transition. The experts fear societal disintegration and lack of cooperation. The experts identify feelings of injustice about the distribution of burdens and benefits as a main driver for societal disintegration and unwillingness to change one's lifestyle. Fair distribution of harms enables collective commitment and public acceptance of policies. Especially the new general climate policies discuss these issues. To the experts, social equality is a key driver to sustainable population growth, too, but the policies entail little discussion of this.

A theme that goes completely missing in the strategies is power relations that prevent change. The biggest threat the experts mention is a fear that nothing gets done, or actions are too little too late. A central element in this fear is that politicians are shortsighted and care more about the next election polls than responsible politics of sustainability. Main actors in this are lobby and corruption by big influencers, such as conservative fossil-dependent or biomass bulk use-dependent corporations and interest groups. In a "good" bioeconomy, leaders are committed, and corporations adopt sustainability targets. Thus, power relations, economic structures, and interest influencers play a major role in the transition. Nevertheless, these relations are not discussed at all, apart from urging for "public" acceptance and active citizens. Should there be more targeted speech addressing the central opinion influencers in the society?

Another issue related to the lack of leadership is social apathy, brought about by the lack of adequate means to communicate the climate urgency. Although communicating the issue should raise alarm and create awareness of urgency, it should still remain sensitive to communicating a just and inclusive transition. This way messages would be designed to reach different groups of people, with awareness and caution not to create a sense of resignation or fatalism. The experts view such sentiments to be a central factor contributing to failures to address climate change through any kind of policy framework.

[80] See, e.g. Jackson (2009)

All in all, the depictions of a "bad" bioeconomy in general engage in a topical critique of contemporary bioeconomy policies and practices. A "bad" bioeconomy combines the key points of critique towards round one bioeconomy policies: it is not mindful of the regeneration rates of renewables, is concerned with quantity over quality of raw material production, aggravates current social and ecological problems, and aims at direct substitution of fossil-based goods with renewables.

Definite conclusions of resemblance of the "good" bioeconomy and the updated policies give way to contradictory narratives and mixed messages. Committed tones to circularity, all-encompassing sustainability, convincing understanding of the limits of technology, and urging socio-political answers take the updated policy to a path towards a "good" bioeconomy. However, reliance on bioenergy and economic growth, the lack of acknowledging the power relations affecting politics, and potentially too soft means in revising the rules of markets cast a shadow on to interpretations about this direction. In the following concluding section, we elaborate our observations more closely.

7 Conclusion

One way to simply encapsulate the changes that have taken place in the bioeconomy discourse of the EU-level policy documents is to describe the new round of policies as "matured" in comparison with the initial program. Bioeconomy in its revised form makes less bold promises and engages in a much more nuanced discussion of limits of possibility and feasibility. At the same time, however, the policies keep the door open for multiple and at times conflicting interpretations, some of which may be very similar to the initial bioeconomy narrative. In this article, our aim was to understand more deeply the directions for bioeconomy, based on both the policy documents and views of experts in the field of bioeconomy. From the expert's views, it is possible to distill a desirable narrative for the futures of the bioeconomy. Many of the elements of a "good" bioeconomy as raised by the experts can also be found in the revised policy documents. Yet, many of the issues that the experts bring up remain unsaid in the documents.

The need to revise the policy framework was to be expected after the harsh criticism directed at the initial bioeconomy programme. Judging by the experts' views, the earlier bioeconomy paradigm is currently widely taken to represent almost the definition of an undesirable bioeconomy future. On the other hand, the issues that have been left out or have not been concretely addressed also tell something about how climate change and other grand challenges are understood on the level of the policymakers. As a general observation, the experts interpret environmental crises as a symptom of a systems-level problematique and are likely to search for more holistic measures as answers to solving them. There, the revised policies are moving closer to the experts' views by agreeing that instead of being a silver bullet to solve multiple pressing problems facing the EU, the bioeconomy- and biomass-based solutions can only be a rather modest part of the compilation of policies,

technologies, and cultural shifts that together can build a more sustainable future. However, in the views of the experts, at the core of the systemic imbalance is a reluctance to change the consumption patterns that sustain the unhealthy economic paradigm. In the EU policies, such questions are mostly avoided, and there lie the biggest discrepancies between the experts' visions for the future and the revised EU policy frameworks.

If we look at the expert's visions for a pathway to a "good" bioeconomy and the urgency they place on critically addressing existing power relations, ending linear bulk use of biomass, revising the current economic paradigm, and massively cutting our primary consumption, we can see that several of these central issues are not raised in the policy documents. What the policies, according to the Delphi panel, should say might be something like the following: "Draw back bioenergy programs, we made a mistake!" or "Stop listening to the fossil- and raw material intensive industries, no matter how important they are nationally!", or even "Forget your short-sighted interests in money or power!". "Stop consuming raw materials altogether!", "Don't seek welfare or status from growth or consumption!", and "Forget the freedom of markets when sustainability is at stake!". It is evident how out of place, naïve, and utopian these sentences would seem in policy contexts. Yet, policies frame the key questions around their area of concern and have a major effect on how we understand and attempt to solve the problems. If relevant areas remain in sidelines, solutions might miss the most important targets.

The theory of the images of the future posits shared visions about the future as an important factor in the shaping of futures. Polak, the main author behind the theory, maintains that the images of the future are culture specific and based on the key narratives, myths, and histories of their originating civilization and culture. Explaining the theory through Western culture, Polak provides plenty of examples as to how one way to narrate a storyline excludes elements that are not fit for that particular context.[81] One can thus argue that the discrepancies between the experts' ideals and the reality of the policy documents lie exactly in the mismatch between the experts' semi-utopian visions (made possible perhaps by the extremely long time span up until the year 2075) and the prevailing cultural image of the futures, tied in closely with the archetypal lifestyle, and beliefs about its foundations in the prevailing economic model. However, the shared images of the future are in a constant process of evolution and change, and the dynamics between utopia and prevailing notions of plausible futures can be argued to be a central force generating social change: "Utopism is the forerunner of all modern conceptions concerning social policy, social organization, and social peace" (Polak, 1973: 178). Thus, it is necessary to discuss alternative images of the future if one aims to advance towards a good society, and a good bioeconomy.

As a particular sidenote, Polak (1973) argues that the late modern Western culture is in general subject to a cultural disruption that is manifested in the dispersing

[81] Similar ideas have been used as base for method and theory development in critical futures studies (the CLA method, Inayatullah 2009) and in peace studies (Johan Galtung's (1981a, 1981b) deep civilizational codes).

of traditional values and founding myths that have so far given rise to Western images of the future. This is argued to bear consequences amongst other things in the form of managerialization of politics. This diagnosis resonates well with a key concern amongst the Delphi panelists' answers regarding the notions of a "bad" bioeconomy (which read essentially as depictions of courses of action that result in more or less total collapse of the contemporary Western ideal state). In such answers, politicians appear as impotent and visionless non-leaders who are unable to ideate or instigate any changes, but rather are merely acting as managers to implement the wishes of the more powerful business elites.

In this study we have explored views derived from bioeconomy experts, who have created a convincing scenario on desirable directions for the bioeconomy. The updated policies were analysed for understanding the extent to which expert's views are in concordance with policy directions and what key elements in the experts' visions are missing from the policy documents. It must be noted that certainly other interpretations about the futures of the bioeconomy directions are possible, and the nature of the Delphi study makes it sensitive to the compilation of experts gathered to provide their judgements. In the current absence of other studies about the revised policy documents, we must rely on our own interpretation of them. Thus, to conclude, in this study we provide a possible framework to understand the direction of the bioeconomy towards the future, but there might be other valid viewpoints and frameworks that this study does not cover. We hope to provide insights to policy-makers and analysts about potentially important future directions and blind spots in bioeconomy and climate policies in need of attention, take part in the first wave of analyses of the updated bioeconomy policies, and offer an example of a research field and policy framework in a transitional phase to relevant areas of scholarship.

At the time of writing the article, we find ourselves in a moment defined by uncertainty regarding the futures of the bioeconomy. On one hand, the EU-level bioeconomy policies point to a future where bioeconomy would take a more considerate position on questions related to sustainability from the perspective of all its aspects. Yet, the policies do not enforce any of these viewpoints and leave rather free space for national-level interpretations.

The bioeconomy has been a dream of an all-replacing biomass giant, but these reveries have proven to be unrealistic hype and wishful thinking. We presume that the future of the bioeconomy will depend on its ability to genuinely dissociate itself from its former unsustainable vision. A move forward has already been made in the official policies, and it remains to be seen how fast the everyday bioeconomy of the real world will catch up with the inevitable change. One sustainable option for the bioeconomy could be to become a partial solution to the grand challenges of climate change and environmental degradation, focusing on small and local refineries and sustainable production methods. However, if we look at the expert's insights, another road ahead comes into view. The bioeconomy could start to promote a wider ideological shift towards a new economic paradigm, searching for prosperity without material growth. This move would help to position bioeconomy as a salient feature in the strategies towards sustainability.

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